UCRL-JC-124872 Abs

# Beamlet Focal Plane Diagnostic

John A. Caird, Howard G. Patton, Lynn G. Seppala
Calvin E. Thompson and Paul J. Wegner

University of California
Lawrence Livermore National Laboratory
P.O. Box 808, L-487
Livermore, CA 94550
(510) 422-6159 / FAX (510) 423-9242

**Abstract submitted to**
**2nd Annual International Conference on Solid-State Lasers for Application to Inertial Confinement Fusion (ICF)**
**PARIS, France (1996)**

The Beamlet is a single aperture scientific prototype of a single beamline of the National Ignition Facility laser. Phase I of the Beamlet demonstration project involved design, construction, and activation of the basic laser system. A milestone shot delivered 6.4 kJ of 3ω (0.351 μm) energy to a whole beam calorimeter using 736 $cm^2$ of output beam area at the end of Phase I in 1994.

The objective of Beamlet Phase II, is to demonstrate all of the key technological requirements of a NIF beamline. The Beamlet Focal Plane Diagnostic (FPD) is a key experimental tool developed in Beamlet Phase II to measure detailed characteristics of the 3ω output beam. The FPD system includes a NIF prototype final focus optical system as well as a telescope which samples and reimages the beam's far field and near field patterns into a number of diagnostic sensors.

The NIF final optics package includes a kinoform phase plate (KPP) to tailor the energy distribution in the target focal plane. Phase distortions introduced by the KPP produce up to a three-fold increase in the peak/average irradiance in downstream near field image planes. The NIF final optics operate close to the damage limit of fused silica at 3ω, so the beam area must be expanded by a factor of 3 before it can reflect without damage from the uncoated first-surface of the fused silica primary telescope mirror. As a result the required primary mirror diameter is nearly 1 meter, and the vacuum vessel which houses the telescope is 55 $m^3$ in volume.

The telescope is comprised of three uncoated fused silica spherical mirrors configured to form an eccentric portion of a centered optical system. The design provides an unobscured aperture and is afocal, meaning that planes in the vicinity of the target plane are imaged with near-constant magnification. Auxiliary optics downstream from the telescope feed an extensive suite of energy/power detectors and imaging sensors.

The primary energy diagnostic is a full-aperture calorimeter located in the vessel near a relay plane of the final focus lens. It measures the total energy in the first, second and third harmonic wavelengths. Energy detectors for the individual wavelengths are calibrated by reference to this calorimeter. Additional detectors measure the 3ω energy in the target plane out to a radius of 20 mm (±3 mrad), and the fraction of this energy that passes through an aperture equivalent to the 3 mm laser entrance hole (LEH).

Imaging sensors include two target plane cameras with ±100 and ±300 μrad fields of view, a multiple image camera which views several planes spaced by 4 mm about the target plane, and two nearfield cameras which measure both large scale (> 1mm) and fine-scale (< 100 μm) beam structure at the final focus lens. Target-plane imaging is

accomplished with near-diffraction limited resolution. Nearfield imaging capability was quantified using a resolution test target at the final focus lens which demonstrated a resolving power of better than 14 lines per mm. This level of resolution is required to characterize the growth of high-frequency UV ripple in the final focusing optics. Measurements obtained using the Beamlet FPD are discussed in another paper to be presented at this conference (i.e., P.J. Wegner, et. al., "Third-harmonic performance of the Beamlet prototype laser.")

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.